

# INDUSTRIAL HYGIENE SECTION

This Industrial Hygiene Section is published to promote sound thought upon and concerning industrial hygiene. To that end it will contain articles, discussions, news items, reports, digests, and other presentations, together with editorial comments. The editorial policy is to encourage frank discussion. On this basis contributions are invited.



Reg. U. S. Pat. Off.

The Editorial Committee will exercise its best judgment in selecting for publication the material which presents most exactly the factors affecting industrial health and developments for control of potentially injurious exposures. The editors may not concur in opinions expressed by the authors but will endeavor to assure authenticity of fact.

## The Science, the Law and the Economics of Industrial Health

Volume 3

October, 1942

Section 4

### How Important is the Protection of Employee Health?

EVERY good American is anxious to do his utmost in advancing our war effort to a victorious conclusion. In these days of stress, that is merely stating a truism. The only question is what constitutes the maximum contribution each individual, considered as an individual, can make to a common cause.

At the present moment the trained technical manpower in the United States is quite inadequate to the needs at hand. The statement has been made that "the total technical and scientific personnel of this country is in the order of one quarter of a million men and that Germany has twice as many men in this classification with a population about two-thirds of ours." Whatever the relative situation, it is recognized that shortages of chemists, engineers of all classifications, and physicians trained in industrial practice have existed

for a considerable period of time. Efforts to train such personnel in two- or three-month courses have been made, and these efforts are very necessary in order to compensate for the obvious shortages. Well qualified observers agree that, however meritorious these efforts may be, they do not solve the problem of fully trained personnel, as much longer periods of training in specialized fields have proved the only way adequately to solve the problems of employee health.

As has been stated many times, the elimination of conditions leading to occupational disease and fatigue of the worker involves the efforts of men trained in various special fields. In addition, these men have, over a period of time through post-graduate study or extensive experience, become expert in the several phases of industrial hygiene: evaluation of health hazards, control of injurious working environment, and industrial aspects of preventive medicine. In each of these special fields men have acquired experience and training which cannot be readily replaced.

In the last few months some of this trained, professional group, already inadequate as to numbers, has been further depleted by individuals taking up commissions in the armed forces. In a number of instances, the men have continued in industrial hygiene or closely allied activities after being commissioned, but there has been an increasing tendency for men to seek commissions voluntarily where the training in industrial hygiene is not to be utilized. If the working population, all of whom will soon be engaged in some form of essential activity, is to be adequately protected and kept on the job at full efficiency, this depletion of trained industrial hygienists must be stopped.

Recent statements by the President at the dedication exercises held at Bethesda, Maryland, indicate that the government desires the protection of the workers' health and efficiency. Other statements by responsible government officials emphasize this attitude and make clear the present intent of official circles.

While this belief continues, it becomes the patriotic duty of the men who have become expert in the field of employee health to remain on their present jobs and the duty of employers to assist in this process by requesting that these men be given occupational deferment. In addition, all such men should be registered in the "National Roster of Scientific and Specialized Personnel" at Washington. Should individual local

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boards rule adversely to occupational deferment, this National Roster should be informed at once at the same time that appeals are being made. It should be recognized that each case is settled on its own merits and that no group deferments are possible. However, if appeals are not made, time is not then available for full consideration by those official agencies set up for the purpose of conserving technical manpower as to where the individual may do the most for his country's war effort.

Some individuals having special training in other fields which are being drawn on heavily for the armed services may feel that they should volunteer for such service. At the present time these trained men would be doing a more patriotic act if they place all the information concerning their status in the hands of boards qualified to review this training, as these boards will have a much better idea concerning the place in the war effort which may best be filled by the trained specialist.—GORDON C. HARROLD, PH.D.

THE foregoing statement, prepared by the Secretary of the American Industrial Hygiene Association during its first three years of existence, is in accordance with recent viewpoints of the United States Government. Under the heading "Manpower," a comprehensive discussion of the situation as it involves scientific and specialized personnel was published on pages 788-790 in the June 25, 1942, issue of *Chemical and Engineering News*, an official publication of the American Chemical Society. Whereas this discussion referred to the quarter of a million personnel included

in the National Roster of Scientific and Specialized Personnel, it refers with even more force to the comparatively small group with training and experience in industrial hygiene.

The mechanics to be followed in the event such a man is called by the local Selective Service Board is outlined in this discussion by the American Chemical Society and is reproduced below:

"If, in spite of everything which can be done, such a man cannot be replaced, there should be *no hesitancy about insisting on further deferment* with a presentation of all the evidence as to the man's necessary position in the organization and the efforts which have been made to train or obtain a man for a replacement. If the local board refuses deferment in the case of such a necessary man, then an appeal should be made by the man immediately on the basis of his training and experience and the necessary nature of the work in which he is engaged. This appeal has to be made within 10 days of the date of the 1-A notice. He should immediately notify his chief of the appeal. If this appeal is lost he should appeal to his State Selective Service Board and should also send a statement of the appeal, together with his draft number and the address of his board, to any professional organization of which he is a member, such as the AMERICAN CHEMICAL SOCIETY and also the National Roster of Scientific and Specialized Personnel, in Washington, with a request that they give any help they can by writing to the local and state boards. It should be emphasized that the only matter involved is maximum effectiveness of the national effort. . . ."

## Control of Industrial Health Hazards

E. C. BARNES,

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Westinghouse Electric & Manufacturing Company,  
East Pittsburgh, Pennsylvania

THE function of our Industrial Hygiene Department is to assist in preserving industrial health. From a rather broad viewpoint it seems that actual industrial health hazards can be reduced to a minimum when the use of potentially hazardous materials is satisfactorily controlled, and this control is confirmed by adequate physical examinations of the employees.

With this principle in mind our program has been developed over a period of nearly 10 years and its results are shown by the experience for the first six months of this year. There were five lost-time occupational disease cases among 85,000 workers. Three of these were cases of dermatitis, one a case of lead poisoning, and one a case of temporary disability from welding fumes. A rather large percentage of these 85,000 persons are exposed to a wide variety of potentially hazardous materials. These exposures include different types of foundry operations, use of many different types of solvents, use of chlorinated hydrocarbons, a great variety of welding operations, many different types of electroplating, extensive use of cutting oils and compounds, use of x-rays and radium.

In large manufacturing operations where the use of many different types of materials is involved, it is necessary for the Industrial Hygiene Department to have a knowledge of the various uses of all these materials so that the plant engineers and supervisors can be advised of any hazards which may be created. So

that our Industrial Hygiene Department can be kept informed of the introduction of potentially hazardous materials, a numbered material card which is utilized in the Engineering Department is referred to the laboratory when any materials are approved for use or when existing materials are changed. This is not a special card prepared for the Industrial Hygiene Laboratory but rather it is a form which is used by the Engineering Department and many shop departments, and contains a description of the material, its engineering characteristics, composition, etc.

Each new card which is issued or old card which is revised is reviewed by the Industrial Hygiene Laboratory, and if the material is of such a nature that it might create a health hazard or a fire and explosion hazard, a suitable caution clause is placed on the top of the card so that all persons using this card or the material will be informed on its characteristics. Only brief general statements are included on these cards such as "Do not breathe dust from this material" or "Avoid contact of this material with the skin." The caution clauses which are included on these material cards serve as a guide to engineering and other supervisors in selecting materials for various applications. More specific information about the actual use of these materials is included in the process specifications. These various individual materials may be incorporated into a number of different processes and these individual processes are described in a standardized method in a Process Specification.

When a new process is developed, the engineer prepares a written description of it, including the names and numbers of all materials involved. This preliminary description is then referred to the Headquarters

Engineering Department where it is revised if necessary and prepared for issue to the shop departments in a standardized form. Necessary approvals are obtained before it is issued.

Prior to issue, all new or revised Process Specifications are referred to the Industrial Hygiene Laboratory for consideration. At this time the Laboratory determines whether the specification as written may create any type of health hazard when it is finally put into production in the shop. When necessary, the proposed process is discussed with engineers and shop supervisors to determine whether the potential health hazards have been given full consideration and there may be some changes made either in materials or the description of the process so that health hazards will be minimized.

In addition to this review of the specification, certain basic information regarding the safety or health hazard is included. On specifications which call for the use of potentially hazardous materials, a tabular heading as indicated in Fig. 1 is included. This tabular heading is self-explanatory to a considerable extent. It classifies the material as to flash point and includes information about the maximum permissible concentration from an explosion standpoint.

Appropriate safety factors are included in the calculation of these limits.

It includes data on the maximum permissible concentration which is permitted at the breathing zone of workers. The maximum permissible concentration for breathing of dust or vapors is divided into two sets of values; the first value being applicable where the workman's exposure may vary between one and eight hours per day, and the second where the workman's exposure is less than one hour per day. Values which are placed in the column headed one to eight hours per day are the generally accepted limits such as the limits recently established as American standards by the American Standards Association. In the column headed less than one hour per day, the values may be either the same as the previous column or a higher value depending on the particular material involved. In those instances, where irritative reactions determine the limit, both values are usually the same. Where the toxic effects seem to be somewhat proportional to the amount of material inhaled, the value for the column headed less than one hour per day is usually indicated as twice that of the

other. In the last two columns of this table, an indication is given as to the need for personal protective equipment. In those cases where accurate data cannot be supplied, a footnote is added to the table indicating the general nature of the hazard from the material.

With such information recorded on each Process Specification, both the engineers and shop supervisors are informed, in a definite manner, as to the limits which must be maintained in order to insure safe operating conditions. Since this information becomes a part of the actual process specification, it becomes a part of the specified operating conditions, the same as the actual description of the process.

When a question arises as to whether the conditions outlined in the Process Specification are fulfilled, the Industrial Hygiene Laboratory is available to make measurements and study the operating conditions. A report of the various concentrations which may have been determined is made to the proper supervisor who can then take any necessary steps to bring his operations in line with the specified conditions.

This procedure of referring the Process Specifications to the Industrial Hygiene Laboratory has proved very helpful under present conditions, where many substitutions of materials are being made. In a recent case it was found necessary to substitute a solvent containing benzol for another which was less toxic. The significance of this change was brought to the attention of the proper supervisors and sufficient changes in the processing equipment were made to insure healthful operating conditions. In this instance it was possible to use totally enclosed equipment, thus avoiding exposure of the workmen.

In those instances where it becomes necessary to establish a routine sampling procedure at rather frequent intervals, the necessary sampling equipment is obtained by the individual plant or department after a preliminary survey by the Industrial Hygiene Laboratory. This procedure is followed only in those cases where suitable personnel are available for operating this equipment and the sampling equipment is suitable for use in this manner.

The results of such routine determinations are reviewed by the Industrial Hygiene Department at frequent intervals.

The Industrial Hygiene Laboratory occupies approximately 1500 square feet of floor space and is

**SAFETY REQUIREMENTS: (For explanation, refer to Process Specification No. \_\_\_\_\_)**

Material	Fire and Explosion Hazards			Potential Health Hazards			
	Flash Point	Maximum Permissible Vapor Concentration		Handling			
	A Less than 80 F	Ovens and Work Places	Breathing Zone		See Safety Manual or Safety Supervisor		
		Per cent Volume in Air	Parts per Million in Air				
	B 80-110 F	Ordinary Equipment	With Flammable Vapor Alarm	For 1 to 8 Hr per Day	For Less than 1 Hr per Day	Corrosive Requires Personal Protective Equipment	May Require Personal Protective Equipment
C Over 110 F							
Benzol	A	0.35	0.70	100	200	No	Yes
Toluol	A	0.33	0.65	200	200	No	Yes

Fig. 1.

Tabular heading used on Process Specifications

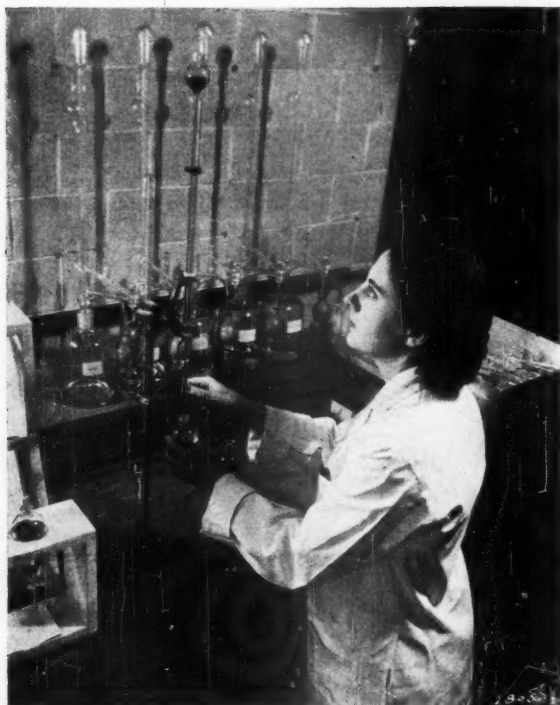


Fig. 2.  
The analysis of lead samples by the dithizone method

located adjacent to the Medical Department in our largest plant. It was designed to be used entirely as an Industrial Hygiene Laboratory and is provided with equipment essential to this type of work. No provision is made for animal experimentation, since all such work is referred to an established laboratory as the occasion demands.

A portion of the laboratory equipment is shown in the accompanying photographs. Fig. 2 shows the equipment used in the determination of lead by the dithizone method. On some occasions this method is also used for determining other metals. Fig. 3 gives a general view of the Industrial Hygiene Laboratory. Fig. 4 shows a portion of the room used for the analytical chemical work.

A separate room equipped with the necessary hoods, etc., is used entirely for chemical analysis. This labora-

tory room is equipped with such special apparatus and glassware as has been found necessary for accurate analysis of many different materials significant in industrial hygiene work.

Another section of the laboratory, which is primarily a physical laboratory, is equipped with such instruments as the dropping mercury electrode, spectrophotometer, refractometer, and gas chamber. The gas chamber is arranged so that different and known concentrations of various types of gases and vapors can be established and used for the calibration of sampling equipment and for the development of new sampling methods.

A separate room is provided for balances, and another separate room for microscopic work. A microprojector is installed in the microscopic room.

A separate office is arranged for the personnel and for the keeping of records, publications and books. There are two industrial hygiene engineers and two chemists in the laboratory.

In addition to air samples and their analysis, laboratory facilities are used to a considerable extent in connection with the pre-employment and periodic physical examinations of employees—for making such determinations as rate of urinary lead excretion and fluoride excretion.

OUR periodic physical examination program is utilized to the greatest possible extent as a means of controlling exposure to various materials in the plant, in addition to its providing a check on the health of the employee.

In order to accomplish this result, a detailed routine procedure for handling the periodic physical examinations has been established. The Industrial Relations Department keeps a rather accurate record of all of the different jobs in the plant. Each job on which there may be from one to 25 or 50 employees is reported on a job specification card such as is shown in Fig. 5. All of the different jobs in the plant have been studied by the Industrial Hygiene Department working in conjunction with the shop supervisors and the Medical Department, and specific pre-employment and periodic examination numbers are recorded on the card to indicate the nature of the examination.

The different types of examinations are as follows: No. 1 is the usual basic type of physical examination. Examination No. 2 covers special chest examination, including x-ray, in addition to the basic examination. This examination is used where there is exposure to

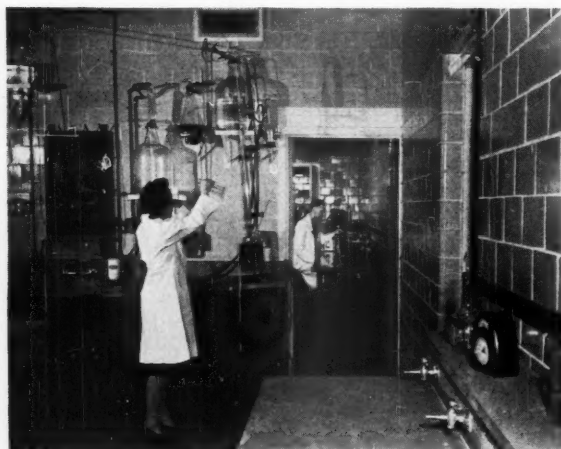


Fig. 3.  
A general view of the Industrial Hygiene Laboratory

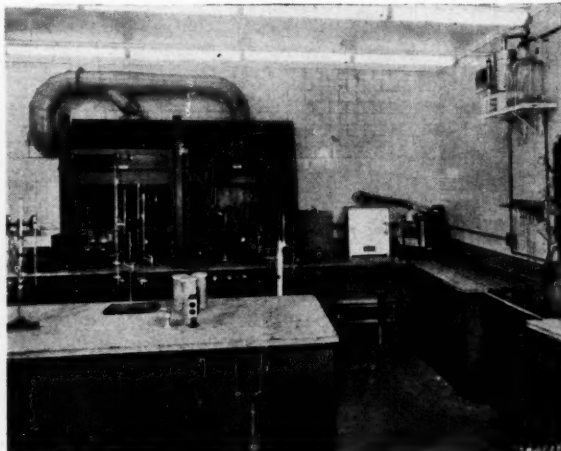


Fig. 4.  
View in room used for chemical analysis

dusts or other materials that might injure the lungs. Examination No. 3 calls for a complete blood examination, in addition to the basic examination, and is utilized on most jobs where there may be exposure to lead, solvents, etc. Examination No. 4 is the basic examination plus a special examination of the skin, and may include patch tests as indicated. It is used where there is exposure to materials which may produce a chronic dermatitis.

By using these four examination numbers, it is possible to indicate, both for the benefit of shop supervisors and for the Medical Department, the type of examination which is required by the materials and working conditions surrounding the employees on a specific job. These examination numbers and the frequency of the periodic examinations are recorded on each of the job specification cards. Copies of these cards are in the hands of shop supervisors, Industrial Relations Department, and Medical Department. On the Medical Department copy of this card, special notes regarding either pre-employment or periodic physical examination factors may be recorded as indicated on the bottom of the card (Fig. 5).

With a system such as this, the examining physician is provided with a full description of each job so that the proper physical examination can be made. In addition to the determination of the physical condition of the worker, it is possible to utilize various methods of determining the exposure to the materials used in the shop by the worker. For example, where the Job Specification Card indicates exposure to lead, or any of its compounds, the examining physician will collect a special urine sample to be analyzed by the Industrial Hygiene Laboratory. If the Job Specification Card indicates exposure to benzol, a special urine sample is collected and analyzed for sulphate ratio by the Industrial Hygiene Laboratory.

This method of determining exposure is helpful both to the examining physician and to the Industrial Hygiene Department. If there is any abnormal exposure, the physician is warned to look for signs of disability or it may explain unusual findings obtained during the clinical examination. Likewise, if abnormal exposure is not indicated it may be helpful in making a diagnosis.

Any time these special samples indicate abnormal exposure, that particular job is investigated by the Industrial Hygiene Laboratory and corrective measures recommended to the proper supervisor. This has been especially helpful in the control of exposure to a number of toxic materials, and this principle is applied whenever satisfactory methods are available. It is much more satisfactory to depend upon the measurement of exposure in this manner than to depend upon unfavorable physiological reactions as shown in the clinical examination.

As an example of the value of this program in controlling exposure and promoting healthful working conditions, the experience during the first six months of this year is of interest. From the total number of urinary lead determinations 35 indicated abnormal exposure. All of the jobs on which these persons worked were investigated by the Industrial Hygiene Laboratory and many corrective measures have been taken to reduce the exposure. Additional urine samples are

#### WHEN POSSIBLE FILL THIS JOB BY PROMOTION

OCCUPATION Welder, Electric Arc. NO. 152 CLASS \_\_\_\_\_ JOB NO. 10  
 DEPT. Switchgear SECTION NAME \_\_\_\_\_ SECTION NO. R-16  
 MINIMUM AGE 21 MINIMUM WEIGHT 130  
 PHYSICAL EXAM.—PRE-EMPLOYMENT NO. 2 & 3 PERIODIC NO. 2 & 3 YRS. 2

CHECK BOTH SQUARES WHEN QUALIFICATION IS ABSOLUTELY NECESSARY. TO MARK ONE QUALIFICATION IS DESIRABLE BUT NOT ESSENTIAL.

<input type="checkbox"/> MAN	<input type="checkbox"/> SPEAK ENGLISH	<input type="checkbox"/> STRONG	<input type="checkbox"/> ACCURATE	<input type="checkbox"/> USE JIGS
<input type="checkbox"/> WOMAN	<input type="checkbox"/> READ ENGLISH	<input type="checkbox"/> QUICK	<input type="checkbox"/> THOROUGH	<input type="checkbox"/> GAUGES
<input type="checkbox"/> TALL	<input type="checkbox"/> WRITE ENGLISH	<input type="checkbox"/> CAREFUL	<input type="checkbox"/> GOOD MEMORY	<input type="checkbox"/> TEMPLATES
<input type="checkbox"/> MEDIUM	<input type="checkbox"/> COMMON SCHOOL	<input type="checkbox"/> PATIENT	<input type="checkbox"/> READ SCALE	<input type="checkbox"/> MICROMETER
<input type="checkbox"/> COLORED	<input type="checkbox"/>	<input type="checkbox"/> OBSERVANT	<input type="checkbox"/> SET UP WORK	<input type="checkbox"/> PRINTS

TOOLS OPERATIVE SHOULD OWN 6" Scale  
 TYPE AND SIZE OF EQUIPMENT Arc Welding Set  
 MATERIAL USED Sheet and structural steel, aluminum  
 NUMBER ENGAGED IN WORK \_\_\_\_\_ INSTRUCTION PAY PERIODS \_\_\_\_\_  
 SAFETY REQUIREMENTS Welders equipment, safety shoes, gloves.  
 REMARKS: \_\_\_\_\_

#### JOB SPECIFICATION—CHECK EMPLOYEES

EFFECTIVE DATE 1/1/41

WESTINGHOUSE FORM 21499 B

KNOWLEDGE AND TRAINING	SPECIFIC DEMANDS	RESPONSIBILITY
POINTS	POINTS	POINTS
_____ BASIC EDUCATION	_____ PHYSICAL APPLICATION	_____ EQUIPMENT
_____ EXPERIENCE	_____ MENTAL APPLICATION	_____ PRODUCT
_____ APTITUDE	_____ VISUAL APPLICATION	_____ SAFETY OF OTHERS
	_____ UNUSUAL FEATURES	
	<b>JOB CONDITIONS</b>	
_____ EXCESSIVE HEAT	_____ DUST	_____ GREASE
_____ EXCESSIVE COLD	<u>X</u> FUMES	_____ DIRT
_____ DAMPNES	_____ ACIDS	_____ NOISE
DESCRIPTION OF WORK <u>Weld sheet steel and structural steel for frames, switchhouses, etc. Weld aluminum and non magnetic parts. Lift up to 100# weights. Part of welding rods may contain fluorides.</u>		
Pre-Emp. Factors <u>Lungs, blood</u>		
Periodic Factors <u>Lungs, blood, eyes, urine if desirable.</u>		
FOREMAN	GENERAL FOREMAN	TIME STUDY DEPT
		SUPERINTENDENT
		OCC. RATE COMM.

JOB SPECIFICATION—CHECK EMPLOYEES  
 WESTINGHOUSE FORM 21499 B BACK

obtained on all these cases to determine whether the corrective measures are actually reducing the lead exposures. From these cases there was only one with clinical symptoms which required a loss of 35 days from work. In all the other cases the exposure has been reduced sufficiently so that loss of time from work is not expected. This illustrates the application of well-known industrial hygiene principles.

### Control of a Lead Hazard

JOHN B. LITTLEFIELD,  
Industrial Hygienist,

*The American Brake Shoe and Foundry Company*

WHEN the present war is over, the industrial hygienist can derive some satisfaction from the fact that he has been able to add considerably to the war effort by aiding in the control of hazards which might otherwise have limited production. This is a preliminary report on just such a case. Being fundamentally concerned with the maintenance of good health in its plants, The American Brake Shoe and Foundry Company has established a Medical and Industrial Hygiene Department to protect the welfare of its employees and to make each plant a better place in which to work.

The greatly increased rate of production in a brass foundry brought on an incipient lead hazard which might have prevented continued operation at full capacity. The problem was attacked with an industrial hygiene and medical survey; the most critical points were relieved by temporary measures while, at the same time, a long-term program involving a radical change in practices was developed. The difficulty of obtaining material and equipment made it necessary to improvise to obtain as much improvement as possible, while production kept to schedule. Although all the data of the medical survey have not yet been compiled it can be stated that no serious cases of lead intoxication were observed.

Four departments will be discussed. Department A consists of a furnace bay, the foundry, chipping and sand blasting sections, all in one large building and the metal storage and classification with welding and another chipping and cleaning section in an adjacent connected building. Department B is another connected building and includes the grinding, bearing lining and shipping operations. Department C is the core room and up to the time this survey was started was right in the foundry but was then moved into a new wing, still open to the foundry at the side most distant from the furnaces. Department D is in a separate building where the only operations are the preparation of various alloys for babbitt and solder.

Three types of furnaces are used for melting brass and bronze; these are ground or pit furnaces, Schwartz furnaces and revolving furnaces. All are gas fired and all of them are located in the furnace bay which is approximately 38 feet high and was ventilated by swinging sash on the upper part of each side. One side of this bay was open to the foundry to a height of 15 feet. The foundry is laid out with floors at right angles to the length of the furnace bay; molds are prepared by hand and by machine and lined up on the floors. Metal is brought from the furnaces in crucibles and large or small open-top ladles which are either transferred from the furnace bay crane to the crane running across the particular floor to be poured or are carried by hand, depending upon the size.

Previous to this survey basophilic aggregation tests

had been made periodically and one-gallon urine samples had been collected for lead analysis. Little correlation could be found on the results of these tests and the urine samples were so difficult to collect that a sufficiently representative number of employees could not be covered. A program of spot urine sampling was initiated and this proved much more reliable as better supervision was possible and less resistance on the part of the employees resulted. Since the basophilic aggregation tests still showed no correlation with the urine analyses and did not prove to be a means of predicting possible cases of lead intoxication, they were discontinued. A definite indication that the spot sampling technique was carried out without contamination is the uniformly low lead excretion observed on new employees who had no previous history of lead exposure. In several instances a new employee did show a high rate of excretion, but in each case investigation revealed that he had come from a plant which had a definite exposure to lead.

Air sampling was done at intervals throughout the six-month period covered in this report. A number of sampling stations were selected and repeat tests were made at each from time to time, so as to include all representative conditions of weather, ventilation and variations in operations. Samples collected at various stations on the molding floors showed a high degree of variability and it was found that samples collected over short periods were too greatly influenced by a peak condition which may have occurred. For example, on a particular floor, if the molds were poured for five to 10 minutes out of this short period, extremely high concentrations resulted, but if the sample were continued for an hour or more the result was much lower. For this reason one hour was selected as the minimum sampling period and in some cases samples were collected continuously for the entire day, changing the collector each hour. The data on each sample include wind direction and velocity, temperature inside and outside, position of ventilators, number and location of windows open, operations in vicinity of sampling point and a list of furnaces in operation. While the sample was being collected the direction of air currents was checked with a smoke tube. An effort was made to collect certain samples when only one operation was in progress, as when only the chipping or sand blast crews were working or when only certain furnaces were in operation.

Air samples for analysis were collected with the electrostatic precipitator using aluminum collection tubes. The tubes were received from the laboratory individually wrapped; as soon as a sample was collected the tube was wrapped in a new sheet of cellophane, twisted together at the ends and returned to the laboratory for analysis. At regular intervals one tube, handled the same as the others except for the actual collection of the sample, was sent in for a blank determination; results on these were uniformly low. The flowmeter on the precipitator was checked on three occasions against an orifice type flowmeter and was frequently checked in the field by means of a velometer.

It was not long before certain conditions which were responsible for a large part of the general atmospheric contamination in the foundry became apparent. The rising hot gases in the furnace bay seemed to cause a good movement of air from the foundry, along the floor, into the furnace bay. By using a ladder and smoke tubes it was found that in general, however, there was a movement of hot gases, often laden with fume from the furnace bay under the crane rails into the foundry. These convection currents served to circulate the con-

taminated atmosphere throughout the entire department. This condition was controlled by three steps; (1) by temporarily shifting some of the heavy melting operations most productive of fumes to the night shift when there were very few men in the foundry; (2) by erecting sheet metal baffles between the furnace bay and other sections of the building down to within seven feet of the floor, and (3) by the installation of power ventilators on the furnace bay to provide more rapid removal of hot gases and fumes. The second step, the erection of the baffles, was finished as rapidly as the sheet metal could be obtained and effected a pronounced improvement. The stack effect of the high furnace bay was increased and we found a movement of air from the foundry into the furnace bay at all points below the baffle with a velocity generally exceeding 100 linear feet per minute. Not only did this greatly improve the foundry but it also provided a level of cleaner air in most parts of the furnace bay except along the far wall. This section is being improved by baffles over the first tier of windows to direct incoming fresh air toward the floor. The stack effect of the furnace bay was further improved and fume was prevented from piling up in one end by dividing this long bay into five sections by sheet metal partitions from the roof down to crane clearance.

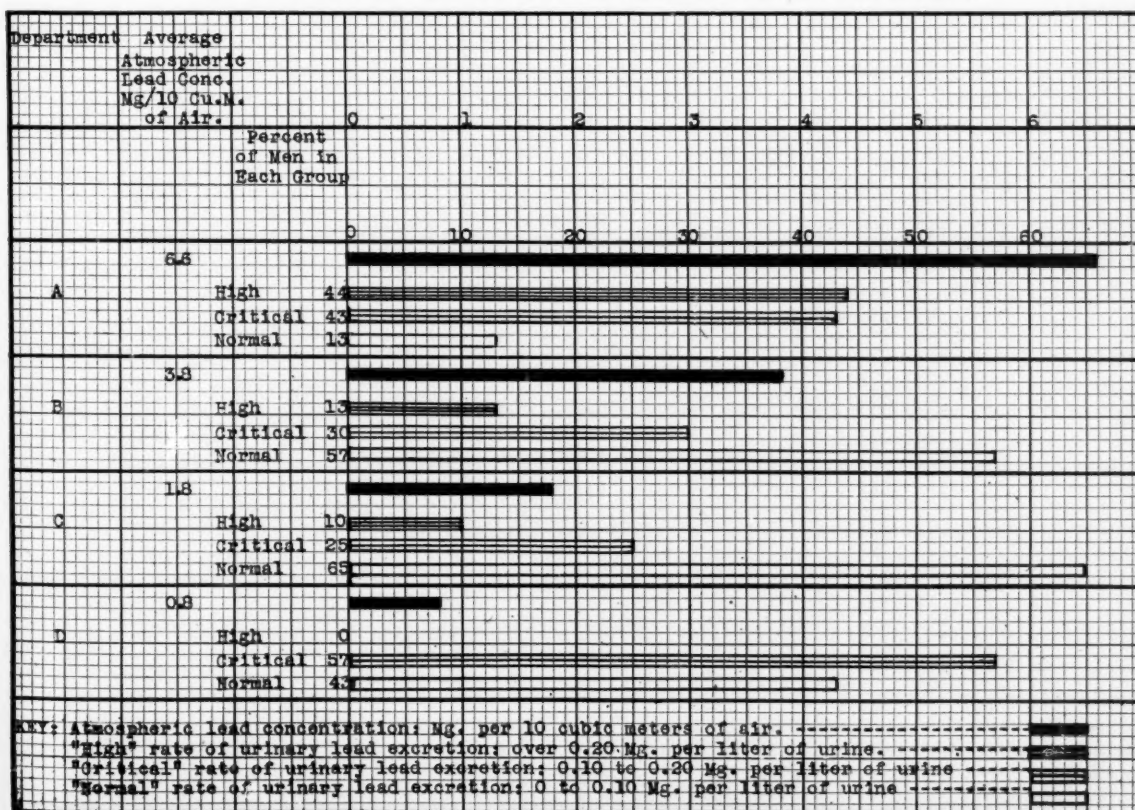
Finally the installation of 17 power ventilators with a total capacity of 144,000 cfm in the roof of the furnace bay serves to give more positive control of the ventilation system regardless of wind direction. This will be augmented by the introduction of tempered clean air along the side of the foundry most distant from the furnace bay. It is necessary to maintain an adequate movement of air across the foundry

to remove the fumes liberated there while transporting and pouring the hot metal.

While this program greatly reduced the exposure of most of the men to lead fume, some men were still exposed to high concentrations for short periods while tapping the furnaces, transporting the ladles and pouring the molds. Although the increased air movement did reduce their exposure it was thought necessary to eliminate these peak exposures by means of respirators. Many respirators had been issued but without care or supervision they became useless and the men objected strenuously to wearing them. In fact they would not keep them on unless they were watched and then usually wore them with the straps so loose that none of the air they inhaled passed through the filters. Two new respirators were provided for each man and marked with his clock number. One man was assigned the job of distributing and cleaning the respirators and each morning he goes through the shop exchanging the clean respirators for the dirty ones, making sure that each man assigned one has it. He takes the dirty respirators to a special room built for the purpose and provided with a large double sink, disassembles them, scrubs the rubber and metal parts in a soap and antiseptic solution, rinses them in hot water and hangs them on a rack where they are dried by a fan. When he reassembles the respirators he uses a new filter in the "Dust" type or replaces the same pair of marked fume filters in the "Fume" type. If the fume filters show sufficient loading he replaces them with new ones.

At the start of this program each man who needs a respirator was instructed in the proper way to wear it and since then we have had much better cooperation.

TABLE 1.  
RELATION OF ATMOSPHERIC LEAD CONCENTRATION TO RATE OF URINARY LEAD EXCRETION



It was not considered practical to require a man to wear a respirator throughout the entire day; instead instructions were issued that they be worn when tapping, carrying ladles or pouring; other men were instructed to wear "Dust" respirators when doing certain jobs where a local dust condition was obvious, as when chipping a dirty casting which had not been previously sandblasted.

Some impinger samples were collected but the dust counts were surprisingly low; this is explained by the fact that the castings are shaken out as soon as the metal has sufficiently hardened and most of the sand is still damp. Aisles and floors are well sprinkled with water before any sweeping is done.

During the six-month period while the possible immediate changes were being effected, and while air samples were being periodically collected a large number of spot urine specimens were obtained from the men in the four departments under consideration. Table I shows graphically the relation found between the average atmospheric lead concentration and the rate of urinary lead excretion for each group. Some explanation of this table will be necessary, for there are many variables to consider.

Department A has perhaps the greatest labor turnover, but, on the other hand, acquires the greatest percentage of new employees with a past history of lead exposure. The 13% of the men in this department who show a normal rate of lead excretion are not confined to the more recent employees; among this group will be found some of the older employees with 15 to 20 years' exposure in this plant. The fact that 44% of the men were in the high range with a rate of excretion exceeding 0.20 mg. per liter, is very serious, and the added 43% in the critical range, 0.10 to 0.20 mg. per liter, only add to the seriousness of the situation. Fortunately the improvements already completed appear to have cut the average exposure to less than half that shown in Table I and the number of men in the high and critical groups is steadily decreasing.

Department B illustrates a somewhat less serious exposure but still one that requires much attention. Contamination of the atmosphere by fume from department A has been practically stopped but we have gone to high-speed grinders which have increased the dust hazard. Additional exhaust ventilation for these grinders is "on order" and some work is planned to determine the size range of the dust in this department. Meanwhile the use of respirators on the dustier operations should help lower the percentage of men in the high and critical ranges.

Department C merits special discussion, for here is a group of men who had essentially the same exposure as those in Department A up until the time this investigation started but since then have had a considerably lower exposure; the average of 1.8 mg. per 10 cubic meters of air shown in Table I has been reduced by the end of this period to well under 1.0 mg. Although 65% of this group is in the normal range of lead excretion it is interesting to note that here the medical survey showed the greatest percentage of symptoms of chronic lead exposure as pallor and lead line. There are two factors which may explain this disagreement between the results of the analysis of spot samples and the medical survey; first, most of the employees are older men who have been in this occupation for a long time as compared with Department A where there is a higher labor turnover, and, second, all of the employees in department C are white as compared with over 50% negroes in Department

A—an important factor in the observation of pallor. This group will serve as an excellent example for study of a number of men who, after having been exposed for a long period of time to an atmosphere contaminated with lead fume in excess of recognized safe limits, are now working in an environment comparatively free of exposure.

Department D exhibits a much different set of conditions; here we have another group of white employees, most of whom have seen many years of service in the same location who have not had any high exposures to lead dust or fume up to the time of this survey; practically all of the air samples showed concentrations of well under 1 mg. of lead per 10 cubic meters of air and, although none of the men showed high rates of excretion, 57% are in what we consider the critical range—most of them just over the borderline between normal and critical.

Electrostatic precipitator samples collected one foot above the kettles in which solder and babbitt are melted showed concentrations of lead below 0.50 mg. per 10 cubic meters of air; the solders were tin base and like the babbitts usually melt below 700° F. Now, however, the shortage of tin has necessitated change to many new alloys, all containing considerably higher proportions of lead with the addition of silver and other metals which have raised the melting points considerably. More effective hoods and ventilators are necessary wherever these changes have raised the temperatures and thus increased the vapor pressure of lead.

#### Summary

A BRIEF description has been given of the steps taken to cope with a lead hazard which has been chronic for many years but which has developed into an acute condition with the greatly increased rate of operation caused by war conditions. At a time when maximum production is essential, necessary steps, many of them temporary, have been taken to relieve the most serious conditions while all possible permanent improvements were under way. This is by no means the end of the road, for a long-term plan of rearrangement of work and change of methods has been developed which is expected to reduce exposure to lead fume to a minimum. For the present we must rely upon control of general ventilation to keep the exposure within safe limits and upon respirators to protect some men from intermittent peak exposure but plan eventually to change operations and methods so that fume may be collected at the source.

Routine air sampling is continuing and the spot urine sampling procedure has been adopted as a permanent control measure. Thus if any unusual situations crop up we will be warned before serious consequences develop. All of our work on this problem has been done with the idea that the only sure way to cure lead poisoning is to reduce the exposure to as far below the recognized safe limits as possible.

IN PRELIMINARY tests for determining tellurium in air samples obtained from ferrous foundries, large quantities of iron collected with the samples interfered seriously with determinations done by the usual methods. DR. M. H. KRONENBERG, Chief of the Illinois Division of Industrial Hygiene, reports that the laboratory of his Division has overcome this difficulty by developing a method based upon measuring the light absorption of the precipitated suspension of tellurium by means of photometer. The method gives reproducible results, within the practical working range—0.05 to 0.7 mg Te.

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